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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item : D.1

United Kingdom

SPECIAL FACTORS AFFECTING INDUSTRIAL DEVELOPMENT IN LESS DEVELOPED AREAS

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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SPECIAL FACTOR AFFECTING INDUSTRIAL DEVELOPMENT IN LESS DEVELOPED AREAS

Prepared by D.W.R.Hill B.Sc.(Econ) Assistant Secretary, Ministry of Commerce and Industry, Federation of Rhodesia and Nyasaland.

1. This paper is written from a knowledge of and experience in the Federation of Rhodesia and Nyasaland, some of the comments may not be applicable to countries which have advanced further along the road of industrialisation.

2. No discussion on industrial development can start off without a reference to the basic infrastructure that must be provided before any sort of productive development on a reasonable scale is possible. Whilst not wishing to dwell on this point in this paper a brief reference to what I consider essential in the infrastructure will prevent their being overlooked. These are

   (a) an adequate transport system to bring material and capital equipment to industry, and to carry the finished products to the market,

   (b) fuel, power and water supplies in adequate quantities and at the right price,

   (c) retail outlets for the products to be sold,

   (d) a banking or credit system to provide working capital,

   (e) buildings in the form of industrial premises, offices, housing and the like,

   (f) efficient Government

   (g) medical and educational facilities.

3. Having mentioned them it is now assumed for purposes of this paper that the infrastructure is adequate for the development of industry. In practise, of course, very large sums have been spent in the past by pioneer industrialists to provide such facilities. The British South Africa Company had to develop most of these services when opening up Central Africa whilst the copper mining companies had to spend very large sums on the Copperbelt making towns out of what was African bush.

4. Agricultural, mining and manufacturing are usually referred to as the productive sectors in an economy; any country which can develop all three basic sectors at the same time has the best chance of achieving a rapid rate of development. However the potential in any underdeveloped territory is dependent on the minerals to be exploited, the area of land available and climate, and the inherent but latent ability of the people. The Federation is particularly fortunate in having minerals in abundance, a large land area with adequate rainfall and people of varying races capable of providing most types of labour.

5. It is no accident that most less developed countries today are basically raw material producers for industry in the more advanced countries. Without going into the historical background to this situation, what is of importance is that the advanced countries have customs tariffs in operation which protect the products of their own industries but allow the entry of raw materials for these industries.

6. This practise inhibits the development of industry in the less developed areas because items which can be produced more economically by large scale methods, cheap materials and labour cannot readily be disposed of on world markets.

7. Strategic considerations have a material bearing on this same issue; in the advanced countries with large munitions industries it is important that the steel industries should be capable of making maximum use of local raw materials including iron ore supplies. Even though it may be more economical to obtain pig iron from certain of the presently under-developed areas, such supplies are often ignored or used only to a minimum extent because of the need to maintain blast furnace capacity for strategic purposes. Instead of iron smelting developing at the site of the iron ore, the iron ore itself is transported to the market with all the attendant waste in railage and shipping that this might entail. The same policy operates in relation to many other raw materials.

8. The less developed areas taken together appear to be producing for export ever increasing quantities of agricultural crops and minerals. There are good reasons for this and these include

   (a) the fact that the development of agriculture is easier because a base for this development already exists even in the most primitive countries and the capital expenditure required is likely to be relatively small,

   (b) the activity of the large mining groups who have been prepared to carry out pioneer investment on a large scale in the less developed areas to maintain the flows of minerals to markets in the more advanced countries.

9. However world trends are and have been towards lower prices for primary products and consequently countries too heavily dependent on such exports are in danger of becoming poorer in a world which is striving to increase per capita incomes.

10. Because of the difficulty of selling manufactured products on world markets, the less developed countries have only their own domestic markets to rely on for the development of manufacturing industry. This generalisation may be modified to the extent that crops and minerals may require to be processed to the intermediate stage to save transport costs in their carriage for further processing in the advanced countries.

11. For the development of a particular manufacturing industry it is safest to consider the domestic market as the basic market. Even when there appear to be markets open in surrounding countries these markets cannot be relied upon for any length of time because of the pressure in all less developed areas to build their own industries.

12. The size of the domestic market available is often assessed from the level of imports of the particular product. In a growing economy it is possible to make forward assessments of the growth likely in the item being investigated. However the obvious point can be made that the domestic market in an under-developed country is likely to be small and many industries may have to be established more on the growth potential than on the actual market.

13. Economic manufacture is possible at many levels of output, particularly when advantage can be taken of the cheap labour that is often available in the under-developed countries. Although allowance must be made for increasing wages which go hand in hand with development, there is definitely scope for the use of machinery which in the advanced countries may have become outmoded because of the high level of labour costs in those countries. Too much emphasis should not, therefore, be given to the most up-to-date machinery particularly when there is an abundance of labour seeking employment.

14. The problem of the examination of whether the local market justifies local production is often made difficult in a less developed area because of a shortage of experts to make such examinations. One way in which this particular problem can be met is by establishing a permanent body specially staffed to make a continuous examination of manufacturing development.

15. An industry which makes use of raw materials locally produced is more likely to bring benefits to the national income of a country than one which relies on imported raw materials. However, this is a broad generalisation and it may often be necessary for manufacture to be commenced based on imported materials as the materials required are likely to be made locally as soon as the market becomes sufficiently large. As an example, steel production in a developing country may have to await the growth of the local market. Steel sheet for a new manufacture may be imported at the outset but when its use increases, at a certain stage it obviously becomes an economic proposition for steel sheet to be made in a local iron and steel industry. Similarly a clothing industry may develop on imported materials, but when the demand increases the materials themselves start to be manufactured in a local textile industry.

16. Where industry is developed based on imported materials, there may in fact be a reduction in national income particularly if a customs duty was levied on the items previously imported. This is only a short term possibility, however, in the longer period with developments in more basic industries considerable benefits will undoubtedly accrue to the economy of the country concerned. Unfortunately it may happen that a poor country may be unable to afford to develop certain industries even when they promise future benefits because of the loss to the national income in the interim period.

17. Even when the assessment of the impact on the national income is favourable manufacturing industry may be difficult to establish because capital or certain types of skilled labour may be unobtainable.

18. Where capital is concerned, private enterprise may be unwilling to make an investment even when the rewards are reasonable because more money can be made by supplying the market from sources outside the particular country.

19. The problem of staffing is probably the most difficult one for developing a new industry in an under-developed country. The top echelon in the industry concerned will probably need to be brought into the country from the advanced countries. This means that such personnel who in any event would be expensive would need to be offered particular incentives to encourage them to move from their own countries. This problem becomes less acute when there has been sufficient time to train local personnel, but even here training facilities may be difficult to establish and such training may have to be provided in associated industries in the advanced countries. Where managerial and skilled personnel are likely to be expensive it is obviously necessary to be highly selective in filling the posts involved and to economise on such posts to the maximum extent.

20. In those under-developed countries which are fortunate in having a small settled skilled or managerial class, the fullest advantage should be taken of the skills of such persons and every effort made to retain them as permanent residents.

21. Local labour in the under-developed countries being unskilled or semi-skilled requires training, and maximum use must be made of what is available. It is important to realise that manufacturing industry dependent on such labour has to incur many costs which are not necessary in the advanced countries. There is usually no class of people brought up to a background of industrialisation as is the case in the advanced countries; the facilities for technical training are often very limited; the education system may only be capable of providing a very low level of general education on the average; hands which have been used to handling a hoe or a spear may not move quickly into using a sewing machine or an electric hand tool. All this means that in the early stages in a new manufacturing industry the productivity of labour may be low, but whilst this may be so it is also true that new skills are readily acquired particularly if jobs can be fragmented so that the range covered by a particular occupation is fairly narrow. Overtime the productivity of labour based on experience in the

Federation shows significant increases leading to lower real costs for labour. In practise, of course, such increased productivity usually leads to higher wages being paid.

22. The relationship of capital and labour in a particular industry should be decided on an assessment of the costs and the economic results of utilising each. Where unskilled labour is plentiful and cheap as is commonly the case in the less developed countries maximum use should be made of this factor of production. Skilled labour including management being relatively expensive must as indicated earlier be used only sparingly. Capital which is often expensive and scarce in developing countries must be economised on to the maximum extent. The methods of production adopted in particular industries sometimes appear to overlook the advantages of the most economic combination of factors of production because there is a tendency to utilise similar production methods as are operative in the advanced countries where all labour is expensive.

23. Even the system of tax allowances designed to encourage greater utilisation of machinery and plant has been copied in the less developed areas from the practise of the advanced countries. Whether this system is relevant to less developed countries in their present stage of development does not appear to have been examined properly but it does lead to the employment of more of the scarce factor of production-capital- and less of the factor in abundance-unskilled labour.

24. There is no quick or straightforward answer to the correct combination of factors of production in any particular industry, this must await expert appraisal preferably by an entrepreneur with wide experience in the manufacture of the product concerned - experience which should be related to varying conditions in a number of countries at different stages of development. There are, of course, many manufacturing industries which require a fairly large market before they can even be contemplated and a country must have taken certain steps along the trail of development before such industries can be considered. Obvious examples of such capital intensive industries are iron and steel, chemicals and oil refining.

25. When the stage is reached for the development of capital intensive industries it is important to utilise the equipment of these industries to the maximum extent if necessary by running three shift production; most labour required for such three shift production should be readily available, but difficulties might arise over an adequate supply of skilled personnel.

26. As a generalisation, the development of secondary industry in an under-developed country starts with those industries serving the basic consumer requirements such as food and drink, clothing and footwear. These industries are likely to be successful even where incomes are very low especially where urban as distinct from rural communities start to form. Industries of this type can be established at the very smallest level and they are also well suited to growth at many different rates.

27. As an illustration of the trends which become apparent in the developing consumer market in African urban areas, the results of urban budget surveys held amongst Africans in the main towns of Northern and Southern Rhodesia between 1958 and 1960 are thought to be of interest. These are detailed below and they do illustrate the importance of the basic consumer needs in low income groups.

TABLE 1. DISTRIBUTION OF ANNUAL EXPENDITURE OF ALL AFRICANS IN THE MAIN TOWNS OF NORTHERN AND SOUTHERN RHODESIA.

Expenditure Head	Total Estimated Annual Expenditure £ m	Relative Expenditure Per Cent
Foodstuffs	14.3	45.8
Clothing and Footwear	5.5	17.6
Fuel and Light	1.0	3.2
Drink and Tobacco	4.1	13.2
Cycles	0.5	1.7
Household Stores	2.3	7.3
Miscellaneous	3.5	11.2
Total	31.2	100.0

28. The foodstuffs of most importance to the African consumer were mealie meal, meat, bread, sugar, fish and vegetables; in clothing shirts and flannel trousers for men, dresses for women and girls and khaki shorts and shirts for boys were mostly purchased; African type beer was the big item in the drink and tobacco group. (Full details of the results of the surveys are obtainable from the Central Statistical Office).

29. One other broad generalisation can be made about the development of secondary industry in less-developed countries. This is that processing of crops and minerals to save transport costs and for preserving purposes may be a very useful means of helping to build up the manufacturing base. In the Federation copper ore is smelted or refined to the pure copper stage before it is exported, tobacco is processed and packed after having been sold on the auction floors, tea is similarly treated whilst iron ore and chrome ore are smelted to be exported as ferrochrome. Other examples of limited processing before export include the production of wattle extract, the treatment of cattle hides, the chilling of beef, and the delinting of cotton.

30. The use of tariff policy as a weapon to stimulate industrial development has a very important part to play in the less developed countries. It is often impossible to manufacture items economically and sell them in competition with products made on a large scale in more developed countries. Similarly these latter countries may have special pricing policies for products they export which make manufacturing in the less developed countries very difficult or impossible. In these circumstances a realistic duty imposed on the imported product encourages its local manufacture.

31. Such manufacture may be only on a limited scale at the outset and may in fact produce an article which is more expensive than the imported item. However as production increases behind the tariff wall and as the local market develops, the price can be reduced because of the spread of overhead costs, and when this development has been taken to its logical conclusion, such an industry is in a position to begin to compete in the export market.

32. Reference was made above to special pricing policies on exports; a country which receives such products is often content to take advantage of the lower prices being charged, as long as they do not compete with the products of its own industry. On the other hand if the imported products do, in fact, compete with local manufactures, they are often treated as dumped and a special penal duty is imposed to prevent their continued importation. There are of course very serious difficulties in the way of proving that the item or items are in fact dumped, and often the damage to local industry is done before dumping becomes known or is proven.

33. Apart from the customs tariff, import control or exclusive licensing may be used to assist industrial development. These weapons are more positive than using the customs tariff but they may give rise to inefficiency in the industry which is being assisted.

34. Even where industry is assisted or could be assisted as indicated above the market provided domestically may not be large enough to sustain economic manufacture of particular items or products, and this consideration leads to the thought that markets may be increased sufficiently to sustain this type of development by broad groupings of countries in some form of economic association behind a common tariff wall.

35. With the large number of under-developed countries in the world and in particular in Africa there is tremendous scope for broad groupings of countries and these groupings could assist the development of each and every country in the group.

To prevent any one country in the economic grouping gaining from association at the expense of the others in the group, it would probably be necessary to use a system of direction of industry or industrial licensing which had that effect. As industrial development advanced in these associated territories, so there could be multiplication of the industries concerned and eventually each country in the economic grouping could have its own widely based secondary industry sector. As an example of this sort of development, an oil refinery normally requires a relatively large market to be an economic proposition and three states may have a sufficiently large market to justify the establishment of such a refinery. With the growth of the area as a whole following the siting of a number of such industries in that area, a stage is reached when a second refinery is justified and eventually after further development all three states will each be served by its own refinery.

36. This summary of the special factors affecting industrial development in under-developed areas has been prepared to assist and speed up the development of secondary industry in the large number of countries in the world which are presently in desperate need of a vast improvement in the living standards of their peoples. These countries, particularly those in Africa, are well supplied with minerals, agricultural potential and labour, but their transition to the status of advanced countries needs a tremendous expenditure of capital and a vast injection of industrial know how. The fortunate countries of the world must double and redouble their efforts to assist the transition of the less fortunate from poverty to plenty.

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SUMMARY

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By D.W.R. HILL, B.Sc., Econ.,
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SUMMARY OF PAPER ON SPECIAL FACTORS AFFECTING INDUSTRIAL DEVELOPMENT IN LESS DEVELOPED AREAS

1. Before productive development on scale is possible, transport, utilities, retail outlets, banking, buildings, efficient Government and medical and eductional facilities must all be available.

2. Pioneer industries in primitive areas have often had to provide such basic infrastructure in the past. The British South Africa Company did this in Central Africa up to 1923.

3. The potential for productive development is related to the minerals available for exploitation, the land available and climate and the latent ability of the people.

4. Most of the less developed countries today are basically raw material producers. Customs barriers in the advanced countries protect industry but allow the entry of raw material. This practise inhibits the development of industry in the less developed areas.

5. Strategic considerations in advanced countries may also inhibit developments in less developed areas.

6. The less developed areas taken together appear to be producing for export ever increasing quantities of agricultural crops and minerals. The agricultural crops because there is always a base for farming even in the most primitive countries which can be developed cheaply, and the minerals because international mining houses are exploiting good quality ores. Unfortunately world trends have been and are towards lower prices for primary products.

7. The domestic market appears to be the only safe market on which to base plans for industrial development. Even where markets appear to be available in surrounding countries these markets cannot be relied on because all less-developed areas are intent on industrial development. Many industries may have to be started on the growth potential rather than on the relatively small actual market in a poor country.

8. There is definitely scope in the less developed areas for the use of plant and machinery which might have become outdated in the advanced countries because labour costs are lower and there is generally a surplus of labour seeking employment.

9. Specially qualified and experienced experts capable of making an examination of possibilities for industrial development are often in short supply in the less developed areas.

10. Vertical industry using local materials will bring maximum benefit to an economy but industry based on imported materials may be a useful stepping stone to this development. However, revenue considerations

and an assessment of the impact on the national income may rule out this sort of intermediate type of development in a poor country.

11. Capital and skilled labour may be very difficult to obtain; capital because more profit can be made by supplying from outside the particular country and skilled labour because it has to be tempted by the offer of high rewards. It is obviously important to economise on both capital and skilled labour to maximum extent.

It is also vital in those countries fortunate in having a skilled or managerial class to encourage such persons to stay permanently.

12. There are additional costs incurred in utilising local unskilled labour in the less developed areas, these include having to educate communities to a background of industrialisation, to provide technical training and to improve the educational level. However unskilled labour has been made remarkably productive in the Federation over time and provided jobs can be fragmented there are great possibilities for increased productivity.

13. The combination of the various factors of production in the less developed countries should bear little resemblance to what is done in the advanced countries, but there is a tendency to make too little use of the plentiful factor - unskilled labour, and too much of the scarce factors - capital and skilled labour. This tendency is accentuated by adopting systems of tax allowances which have relevance in the advanced countries.

14. The development of secondary industry usually starts with the manufacture of basic consumer requirements - food and clothing.

15. Capital intensive industries should make maximum usage of such expensive plant and machinery by running on a three shift basis.

16. The processing of crops and minerals to save transport costs and for preserving purposes is another field for the development of secondary industry.

17. Customs duties at a realistic level may be necessary to ensure local production can make an impact in competition with imported products. Special treatment may be necessary to counter dumping of imported products.

18. Import control and exclusive licensing are other weapons to assist the development of secondary industry.

19. Economic groupings of under-developed countries could assist industrial development by providing the right sized market for the products which require large scale production. Direction of industry in such economic groups would ensure all territories benefited therefrom.

20. The fortunate countries of the world must redouble their efforts to assist the transition of the less fortunate from poverty to plenty.

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CONFÉRENCE DES NATIONS UNIES
SUR L'APPLICATION DE LA SCIENCE ET DE LA TECHNIQUE
DANS L'INTÉRÊT DES RÉGIONS PEU DÉVELOPPÉES

Point de l'ordre du jour : D.13

France

DONNEES GENERALES ET PROBLEMES DE L'INDUSTRIE DU CIMENT EN AFRIQUE OCCIDENTALE ET EQUATORIALE

Par M. André MERCIER,
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Société d'Etudes pour le
Développement Economique et Social

Les mémoires rédigés à l'intention de la Conférence des Nations Unies sur l'application de la science et de la technique dans l'intérêt des régions peu développées sont des documents de travail. Ils sont publiés tels qu'ils ont été présentés et les assertions et opinions qu'ils contiennent sont celles de leurs auteurs.

NOTES

1. Les mémoires choisis pour être présentés en séance générale pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

2. Les mémoires choisis pour être présentés en séance spéciale pourront être obtenus à la Conférence dans l'une seulement de ces langues officielles.

3. Les résumés qui ont été rédigés pour tous les mémoires par les auteurs de ceux-ci pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

4. Préalablement à la Conférence, les mémoires et les résumés ne feront pas l'objet d'une distribution générale mais d'un tirage restreint destiné aux délégations des gouvernements et autres participants officiels. La publication et la distribution générale des actes de la Conférence s'effectueront conformément aux règles et pratiques agréées par le Comité des publications des Nations Unies.

DONNEES GENERALES ET PROBLEMES DE L'INDUSTRIE DU CIMENT EN AFRIQUE OCCIDENTALE ET EQUATORIALE

par André MERCIER, Conseiller Technique
à la Société d'Etude pour le Développement Economique et Social

I - Les caractéristiques du marché du ciment et son évolution.

1° - Caractéristiques du marché du ciment dans les pays de l'Afrique Occidentale et Equatoriale.

1 - Il s'agit de pays à population peu nombreuse, très dispersée (nombre d'habitants au km2 très faible) et d'un niveau encore peu élevé de développement économique (revenu par habitant inférieur ou de l'ordre de 100 $).

2 - La consommation annuelle de ciment dans chaque pays reste faible (85.000 tonnes dans les quatre pays de l'Union Douanière Equatoriale, 35.000 tonnes au Togo, 60.000 tonnes au Cameroun, 60.000 tonnes au Dahomey, 140.000 tonnes en Côte d'Ivoire, par exemple). La consommation par habitant varie de 16 kg en U.D.E. à 44 kg en Côte d'Ivoire).

3 - La consommation totale de ciment accuse parfois de fortes variations, la réalisation de certains grands travaux (construction de barrage hydro-électrique par exemple) entraînant des pointes dans les importations. Voir par exemple, la courbe des importations au Cameroun.

4 - Les frais de transport grèvent considérablement le prix de revient du ciment dans les villes de l'intérieur. C'est ainsi, par exemple, que le ciment arrivant à Pointe-Noire à 4.480 F CFA la tonne revient à Bangui à 13.265 F CFA (transport: 8.175 F CFA) et à Moundou ou Fort-Archambault à 19.000 F CFA environ).

2° - Prévision d'évolution des consommations de ciment dans ces pays.

1 - Le seuil minimum d'une cimenterie classique à four tournant est de l'ordre de 80.000 tonnes. Les consommations actuelles sont le plus souvent trop faibles pour que l'on puisse envisager une fabrication locale. Peut-on espérer un développement suffisamment rapide de la consommation pour rendre rentable, dans un avenir assez proche, une cimenterie?

2 - Les méthodes "classiques " de prévision (ajustement d'une droite ou d'une courbe sur l'évolution des consommations passées, liaison entre consommation de ciment et certains variables macro-économiques, etc...) sont

Etant donnéles besoins globaux de la plupart des pays industriels, le four rotatif est aujourd'hui le plus répandu. Parallèlement à cette évolution, des recherches constantes ont amélioré la technique du four droit qui n'a jamais été complètement abandonné (conditions locales de marché ou de production). La quasi-totalité des difficultés est aujourd'hui surmontée: la productivité est très correcte pour des tonnages de quelques dizaines de milliers de tonnes, et les rendements en matières (combustible) sont mêmes supérieurs à ceux des fours rotatifs. Par contre, l'état actuel de sa technique n'autorise pas encore l emploi de fuel ou de gaz naturel comme combustible et il convient donc de prévoir son approvisionnement en charbon.

2° - Conditions de la production dans les pays en voie de développement.

Sauf de rares exceptions (Pakistan, Inde, Nigeria), la plupart de ces pays sont caractérisés par une assez faible densité de population. Les consommations de ciment par habitant que l'on peut relever sont, par ailleurs, très faibles. Ceci explique que le plus souvent, il ne soit pas économiquement rentable de vouloir implanter des cimenteries du type de celles que l'on rencontre en Europe ou aux Etats-Unis par exemple, c'est-à-dire des fours rotatifs. Ceux-ci, en effet, s'adressent à des marchés dépassant 80.000 à 100.000 tonnes/an. Etant donné la dispersion des populations et la faiblesse des consommations par habitant, une telle solution impliquerait la nécessité d'accords commerciaux de longue durée entre pays voisins, ou parfois de transporter le ciment produit très loin de l'usine pour reconstituer un marché suffisant, ce qui se traduirait par un coût de transport prohibitif, surtout si l'on tient compte des conditions de transport, souvent difficiles dans ces pays. Le ciment produit localement ne peut pas même alors être compétitif avec le ciment.

L'utilisation du four droit dont il existe divers modèles, permet au contraire d'obtenir des prix de revient très acceptables pour des productions annuelles descendant jusqu'à 30.000 tonnes au moins. Dans des conditions normales d'exploitation: calcaire et argiles sur place, charbon importé à des prix normaux, les prix de revient ex-usine que l'on peut prévoir s'étagent entre 13.000 et 10.000 F CFA par tonne (prix calculés pour un projet au Nord-Cameroun) suivant la production admise (20.000 à 50.000 tonnes/an). Le marché correspondant à cette production est alors suffisamment proche de l'usine pour permettre une compétitivité assez grande par rapport aux ciments d'importation.

On peut souvent prévoir une baisse du prix moyen, facteur puissant de développement et d'augmentation de la consommation. lorsque de telles conditions existent; technique de production adaptable à une structure de marché donnée, il devient possible de déterminer la dimension optimum à donner aux installations.

En effet, le prix de revient moyen unitaire d'une tonne de ciment rendue client est, pour la partie principale, la somme du prix de revient usine et du prix de transport jusqu'au client. En fonction de la production, le prix de revient ex-usine est une courbe monotone décroissante; par contre, le prix de revient du transport est une courbe dont la forme dépend du marché, de sa densité, des conditions de transport, mais croissante avec la production puisqu'en moyenne il faudra transporter le ciment plus loin, lorsque celle-ci croit. Le prix de revient total est la somme de ces deux éléments principaux, variant en sens inverse, il existe donc un minimum correspondant à l'optimum théorique du niveau de la production.
rarement applicables dans ces pays, par suite du manque de données. La méthode exposée ci-après permet toutefois d'émettre une hypothèse sur les taux de croissance possibles.

3 - Cette méthode est basée sur la comparaison des consommations de ciment par habitant dans des pays ayant atteint des stades différents de développement stade mesuré, à défaut d'informations plus adéquates, par le niveau du revenu par habitant. Une courbe a été ajustée à main levée sur le nuage de points ainsi obtenu; mais il convient de bien préciser que rien ne ppouve, a priori, que le nuage doive se déplacer dans l'avenir parallèlement à cette courbe. C'est pourquoi pour tous les pays pour lesquels les données étaient disponibles, la corrélation temporelle entre les deux données en question a été étudiée; aux points

représentatifs de ces pays sur le graphique ci-joint ont été associées des flèches dont la pente traduit l'élasticité temporelle de la consommation de ciment par rapport au revenu par habitant. Le sens général de ces flèches tend à prouver qu'à une augmentation donnée du revenu par habitant correspondra un accroissement de la consommation de ciment plutôt plus important que celui suggéré par la courbe C. Au niveau de revenu de l'ordre de 100 $ par an et par habitant, la pente de la tangente à la courbe C est d'environ 1,8; par suite d'une augmentation du revenu par habitant de 10 % par exemple devrait correspondre un accroissement de la consommation de ciment par habitant d'au moins 18 %.

4 - Malgré la rapidité de cette croissance, la consommation de beaucoup de ces pays restera encore très longtemps au-dessous du seuil de rentabilité d'une cimenterie de type classique. Pourtant, pour ce produit plus que pour d'autres, la protection " distance" est particulièrement forte. C'est pourquoi on est conduit à rechercher si de nouvelles techniques de production ne peuvent pas apporter une solution à ce problème.

II - Les conditions de la production de ciment.

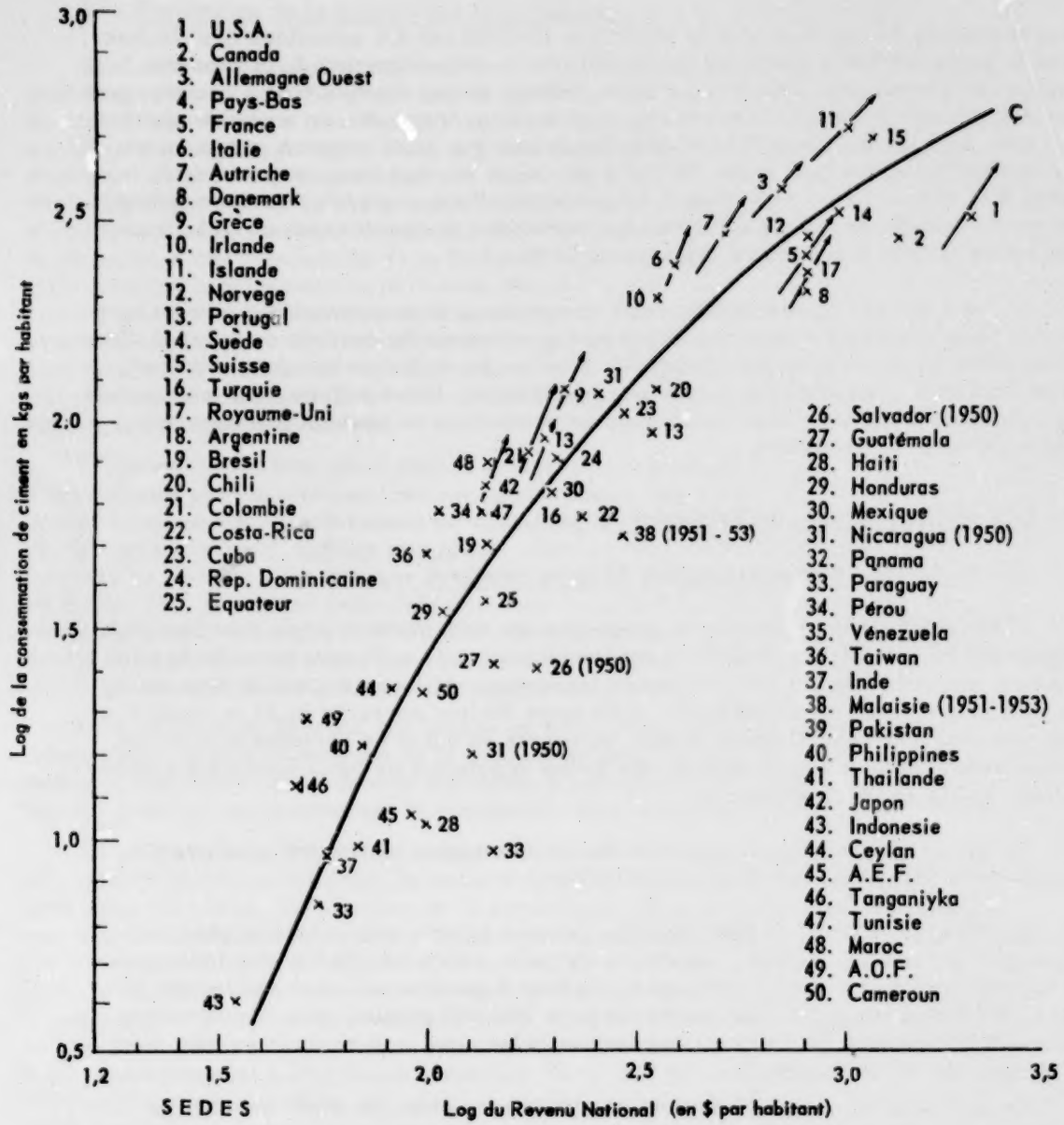
1° - Caractéristiques techniques de la production.

L'évolution de la technique de production du ciment est typique dans les pays fortement industrialisés ou dont la consommation, liée à l'importance de la production, est très élevée: les premières techniques utilisées étaient le four droit, en voie sèche, dont les rendements théoriques étaient corrects mais la productivité par heure de travail assez faible, et posant en outre un certains nombre de problèmes techniques pour obtenir une bonne régularité de fonctionnement (granulation, grille de four, vidange).

De plus, l'augmentation rapide de la consommation de ciment conduisait à mettre très vite plusieurs fours en parallèle.

Au début du siècle, le four rotatif a fait son apparition, utilisé le plus souvent en voie humide, laquelle est moins exigente sur la régularité des mélanges et les qualités de charbon à employer. Ce four a permis de créer des unités de production dépassant 100.000 tonnes/an puis 200.000 tonnes, pour atteindre jusqu'à 400.000 tonnes, il y a quelques années, alors que le four droit restait dans la gamme de 50.000 tonnes/an.

On trouve donc, avec l'industrie du ciment, un exemple d'une conception technique, mise en veilleuse pendant une certaine période, qui peut se trouver particulièrement bien adaptée aux problèmes des pays neufs. Il faut insister cependant qu'il s'agit d'une conception ancienne mais non d'une technique ancienne, celle-ci ayant continué à évoluer et progresser,



GRAPHIQUE No3 - Consommation de ciment en fonction du revenu national.

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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.13

France

GENERAL DATA AND PROBLEMS OF THE CEMENT INDUSTRY IN WEST AND EQUATORIAL AFRICA

By André MERCIER,
Technical Consultant,
Société d'Etude
pour le Développement
Economique et Social

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

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GENERAL DATA AND PROBLEMS OF THE CEMENT INDUSTRY IN WEST AND EQUATORIAL AFRICA.

By
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SOCIETE D'ETUDE POUR LE DEVELOPPEMENT
ECONOMIQUE ET SOCIAL.

The industrialisation of less developed countries normally benefits from the experience of the more developed countries in the choice of processes to be applied. However, the particular conditions of the new countries (especially as far as the extent of the market is concerned) occasionally require different solutions, calling for a technique that has been abandoned or neglected by the industrialised countries. These earlier techniques can moreover improve by benefiting from the latest advances in science. This applies to the steel industry, cellulose manufacture and the production of building materials.

The idea of cement plants in West and Equatorial Africa, which is the object of this memorandum, is another example.

The production of cement in the developed countries has almost exclusively been carried out in rotary kilns. These can be highly mechanised and they fit perfectly into very large enterprices of high productivity. Single units producing up to 2500 tons per day are thus feasible with a reduced labour force. On the other hand investment costs are high and depreciation and finance charges have a marked effect on the manufacturing cost. Even at a production rate of less than 200 tons per day the effect of these items is too pronounced for competitive prices to be achieved unless conditions are exceptional.

With some rare exceptions (Pakistan, India, Nigeria, Senegal, etc.) the majority of the developing countries are characterised by a cement consumption that is too low or too scattered and by the necessity to transport the cement

produced over long distances in order to reach an adequate market. Even if advantage is taken of commercial agreements between neighbouring countries, this still constitutes a serious burden for a base product which, on the contrary, one would like to see at a lower price.

Utilisation of modern shaft kilns, however, of which several types now exist, permits production at acceptable manufacturing costs with an output of 70-100 tons per day. Under normal production conditions, with local raw materials and even with the plant and its market far from the nearest port, there is even a chance of appreciably reducing the average price per ton delivered to the customer.

It is important, though, to note that the use of the shaft kiln in its present state requires coal as the fuel used and in this respect it is not as flexible as the rotary kiln. On the other hand it is much more so as far as its operation is concerned, because it is very easily worked at reduced capacity and shut down. Consequently it can be operated in one or two shifts and shut down on Sundays.

The paper also describes a new method for the evaluation of likely cement requirements in a given country and for thus quickly estimating short-term demand. The basis of this method is a comparison of the per capita consumption of cement in countries in different stages of development, the stages being determined by reference to the per capita income level.

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Agenda Item: D.5.1

Finland

THE PULPING PROCESSES OF TODAY AND THEIR MAIN CHARACTERISTICS

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The pulping processes of today and their main characteristics.

Waldemar Jensen, Professor, Doctor of Technology

Managing Director of the

Finnish Pulp and Paper Research Institute

The population of the world is constantly increasing, and the same thing is true of the paper consumption per head. The vigorous expansion which characterizes the pulp industry of today must be viewed against the background of these facts. In fact, this expansion mainly appears in constantly rising production figures. Alongside this rise in production, however, there is in progress a technical development which partly results in the perfection of processes already in existence, and is partly concerned with long-term changes of a radical nature.

The predominant raw material for the manufacture of paper, board, rayon, and cellulose ethers and esters is the cellulose fibre of hardwoods and softwoods. Further to this, agricultural fibres and other grasses are of importance as raw material for papermaking in countries where suitable types of wood, do not grow. For instance, bamboo is a leading raw material for papermaking in India and other east Asian countries. Straw, bagasse, esparto and reed have also proved themselves acceptable as raw materials for papermaking. Today, about 98 per cent of all the pulp manufactured in the world is made of wood.

Before fibres can be manufactured into paper and the other products mentioned above, they have to be removed from the substances with which they are connected in the plant. This is achieved by means of different pulping processes. Pulping is effected by various combinations of energy in the form of heat, chemicals, pressure and mechanical abrasion. The nature of the resultant fibrous products depends on the type and degree of the treatment utilized.

When wood is used as raw material, there are traditionally two main types of pulp, viz. chemical woodpulp with a yield of about 35 per cent, and mechanical woodpulp with a high yield of about 100 per cent, both on a wood basis. In this respect, the present-day picture is changing radically. It is in fact possible to make types of pulp in any yield desired between 50 and 100 per cent by the modification of already established processes, and by the introduction of new ones. By doing this pulps with quite different properties, and suitable for various purposes, are obtained.

To provide a survey of the situation, the most important old and new processes on a wood basis which are in use today can be arranged in the pattern indicated in Annex I.

In this scheme, the pulps have been classified according to the yield, but it must

be emphasized that there exists no generally accepted basis of division or any accepted nomenclature. A classification which is more correct theoretically might perhaps be made on the basis of the mechanical work needed in order to defibrate the wood after it has been to some extent prepared by chemical treatment. As regards chemical pulps this work amounts to practically zero, whereas the corresponding value for mechanical wood pulp is about 1000 kWh/ton of pulp.

Agricultural fibres may also be treated with some of the pulping processes mentioned, but frequently special processes are employed suited for each kind of fibre used.

After this general introduction, a brief discussion follows of the particular processes.

1. Sulphite Process

The conventional sulphite pulping process is principally based upon the making of chips from logs of wood by means of a chipper, and then pulping the chips in a water solution of acid calcium bisulphite containing an excess of SO_2. Although in its traditional form this process continues to dominate the manufacture of sulphite pulp, the use of bases other than calcium, for example ones which are soluble has recently shown a constant increase in some pulp producing countries. This is especially true with respect to magnesium, sodium and ammonium.

Right up to the second world war, the world production of sulphite pulp was greater than that of sulphate pulp; but now the roles have changed. During the last fifteen years, only very few new sulphite mills have been built, by virtue of the wood species problem, and the enhanced versatility of kraft and semichemical pulp. The most evident advantage of the sulphite pulping processes is that bright and easily bleached pulps are obtained from them. This was especially important when bleaching technique had still not attained a sufficiently high level. However, it is possible today to bleach a sulphate pulp to the same brightness as a sulphite pulp without loosing pulp strength. This satisfactory result has been achieved by the use of chlorine dioxide as bleaching agent. This chlorine dioxide bleaching technique is currently making rapid progress throughout the world. The main raw material for this process is spruce, but hardwoods are also quite commonly used. Nevertheless, this process is not especially well suited for making pulp from one-year plants, but it has in isolated cases been utilized for the manufacture of pulp from bamboo and reeds. The major disadvantage of the conventional sulphite process is the difficulty experienced in pulping some common wood species. Species which are high in resins and certain extractives cannot readily be pulped, and furthermore the logs have to be sound. Pine is one of the species which are impossible to pulp by the conventional sulphite process.

The main chemicals used for the production of pulp by the sulphite process are sulphur and limestone. The consumption of these chemicals is as follows: sulphur about 75 to 100 kg a/ton a. d. pulp and limestone 13 to 18 per cent of a. d. pulp. The consumption varies, dependent upon the pulp quality, the composition of the cooking liquor and the recovery of SO_2. During the whole process of manufacture large quantities of water must be available and this water must be sufficiently clean for the purpose.

However, at the present time the sulphite process is undergoing vigorous development. One of the most obvious improvements is the introduction of evaporation and combustion of the waste liquor. This brings about an improvement in the heat economy of the process, and at the same time the water pollution prob-

lem diminishes. The most thorough-going modification is the introduction of cations other than calcium into the cooking liquor. Magnesium, sodium and ammonium all give easily soluble compounds, a fact which helps the pulping process in many different ways. The penetration of the chips becomes faster, the yield higher, and the properties of the produced pulp are improved. Furthermore, this conduces to the possibility of using pine wood and also barkdamaged logs as a raw material for sulphite pulping.

Magnesium and sodium can both be recovered on the evaporation of the waste liquour and brought back into the process. The conditions are especially favourable as regards magnesium. On the other hand the recovery of the sodium base is more complicated but present day technique has solved this problem also.

The soluble bases also make it possible to carry out "multistage cooks". With sodium as base it is quite possible to start cooking under less acid conditions than in the case of calcium. After the penetration stage, sulphur dioxide may be introduced into the cooking liquor in order to promote the dissolving of substances which must be removed from the wood. Finally, it is possible in particular cases also to give the pulp a purely alkaline treatment. This is of particular benefit when dissolving pulp is being made. In fact, there is every possibility of modifying from a pure sulphur dioxide cook to pulping with caustic soda alone.

Today, sulphite pulp has in many cases had to yield to sulphate pulp; this is particularly so when the pulp is used for the production of extrastrong papers. It must be strongly stressed that the strength of pulp is by no means the essential factor in every connection. In many instances, the strength plays a subsidiary role, while properties such as printability, absorption and so on come to the fore.

The main advantage of the sulphite process is its extreme flexibility. It is possible to produce pulps with properties which are well suited for the most divergent purposes by varying the pulping conditions.

Pulps made by the acid bisulphite process may with advantage be used for making greaseproof and glassine, different kinds of printing papers and tissue papers. It is a part of the furnish for making newsprint. Well purified bleached high α-pulps made by this process are used for the manufacture of rayon and different kinds of cellulose esters and ethers. Bleached sulphite pulps made of bamboo are used for making writing and printing papers, and bristol board, for dissolving purposes and so on.

2. The Mg and Na bisulphite processes

The acid nature of conventional sulphite cooking liquor explains why the fibres are to some extent attacked during the cooking process. In order to avoid this, pulping methods have been developed which are based upon the use of the same chemicals, but with no excess of sulphur dioxide in the cooking liquor. The magnefite process utilizes acid magnesium bisulphite ($Mg(HSO_3)_2$) as chemical, whereas the Arbiso process uses acid sodium bisulphite ($NaHSO_3$). In both cases, the cooking is carried out with no excess of sulphur dioxide.

These processes allow of the use of a variety of wood species, which can if desired also be mixed. They are particularly appropriate for hardwoods. Wood species not previously found suitable for acid sulphite pulping can also be used.

The chemical consumption depends upon a number of different factors such as

the wood species, the type of base, the yield, the cooking temperature and so on. It is doubtful whether any reliable figures can be given with respect to the consumption of chemicals, because of the short time these processes have been in use, but it can be said that chemical recovery is possible, and that this recovery is carried out in a particularly simple and effective way and is already established for magnefite. Both of these processes also use large quantities of good quality water.

In these processes, the cooking may be carried out at a higher temperature, and thus takes a shorter time than in the case of the conventional sulphite cook. The pulp becomes in some respects stronger and the yield higher. These methods are extremely flexible with respect to pulp quality, and appear to be very interesting and promising variants of the sulphite pulping process. Chemical, high-yield and semi-chemical pulps made of chips may be manufactured by these two methods. These pulps are more difficult to bleach than the acid sulphite pulps but easier than the sulphate pulps.

3. Sulphate process

In this process, also termed the "kraft-process", all the known species of wood may be puiped satisfactorily. On a percentage basis, pine is the most used raw material, but an increased use of hardwoods is a typical factor of the development of the present-day sulphate process. This process is also a popular pulping method for making paper pulp out of straw, bagasse, bamboo and reeds. However, esparto is mainly pulped by means of sodium hydroxide alone i. e. the soda process. The sulphate process has always been characterised by effective heat economy and chemical recovery. The evaporation of the waste liquor also consitutes an integral part of this process. The active chemicals are sodium-hydroxide (NaOH) and sodium sulphite (Na_2S). The loss of chemicals during pulping is compensated by the addition of sodium sulphate (Na_2SO_4) to the system. The consumption of chemicals i. e. alkalies calculated as sodium oxide (Na_2O) is about 300 kg/ton of a. d. pulp, or in other words 12 ... 14. 5 kg Na_2O/100 kg wood. A part of the chemicals consumed is recovered and only the rest, i. e. the loss has to be compensated by the addition of sodium sulphate.

The development of the current sulphate process is above all indicated by the expansions of the mills into very large units. That is explained by the method becoming more economic with increase in size of the units. The most noteworthy technical development during the past ten years has been the continuous cooking method already established in many mills.

The paper strengths attained are highest of all chemical pulps. The unbleached pulp is very dark, but it can be bleached to high brightness and strength with the aid of chlorine dioxide. Since chlorine dioxide has joined the family of bleaching agents and has been taken into use, the bleaching of sulphate pulp has become increasingly common, and a relatively large percentage of currently produced sulphate pulps are bleached. Nevertheless, the bleaching requires more stages and chemicals than do sulphite pulps. One advantage of this process is that tall oil and terpentine are produced as byproducts.

In the main, the wood pulp produced by this process is used for making kraft paper and kraftliner. Bleached kraft pulp made of wood has also been used for making food board and different kinds of printing papers. Bleached kraftpulp made of straw, bagasse and bamboo is used for the production of writing and printing papers. Acid prehydrolysis of wood chips prior to normal kraft pulping and bleaching results in a pulp which makes a excellent raw material for dissolving purposes.

4. The semichemical process

Fundamentally, the semichemical process consists of a moderate chemical cook

followed by mechanical fiberizing which completes the reduction of the chips to fibres. All of the chemical pulping processes known at present may be adjusted into the semichemical high yield range by reducing the amounts of chemicals applied, the pulping time and the pulping temperature. The most generally employed semichemical process is the Neutral Sulphite Semi-Chemical process, known in the world market as the NSSC-process.

Hardwoods are the main raw materials for the NSSC-process. Indeed, this process has been developed with a view to finding a use for hardwoods. Usually the cooking liquor is a mixture of sodium sulphite and sodium carbonate, bicarbonate, the sodium sulphite being the major component which serves to delignify the wood. The sodium carbonate neutralizes excess acidity, and thus prevents acid hydrolysis of the pulp. The amount of sodium sulphite required for pulping to a yield of about 75 per cent is normally within the range of 7 to 15 per cent on the basis of the dry wood content. The carbonate generally amounts to about 1/5 to 1/2 of the quality of sulphite.

After having been softened by the chemicals, the chips are transferred to refiners of which the disc type is the most common. During this operation, which is the heart of the process, the chips are reduced to fibres. The consumption of energy for the refining is usually within the range of 300 to 600 kWh/ton pulp.

Semichemical pulp made from wood has many characteristics which make it well suited for use in a wide range of papers and boards. The pulps produced are light in colour, but an increased alkalinity during cooking tends to give a darker pulp. Neutral sulphite semi-chemical pulps are characterized by ease of hydration, low opacity and great strength. NSSC-pulp is especially well suited for the manufacture of corrugating and liner board where an excellent degree of stiffness is an essential requirement. NSSC-pulp may be bleached by the utilisation of large amounts of chlorine and chlorine compounds, yielding a white pulp well adapted for glassine manufacture.

Semichemical pulps have also been produced with straw and bagasse as raw materials. Straw is treated by the monosulphite-method, whereas bagasse is pulped by the NSSC-process. These pulps are mainly used for the production of corrugating board.

The NSSC-process becomes more capable of competing with other methods if the mills are built sufficiently large to make cooking chemical recovery practicable, but smaller plants also can be run on an economic basis. Dried NSSC-pulp is very hard to reslush, and for this reason the NSSC-mill has preferably to be built and to work in conjunction with a board or paper mill using this pulp as raw material. However,it is possible that manufacturing methods devised in the future will eliminate these difficulties.

The distinction between semichemical and chemi-mechanical pulping is that comparatively little dissolving of wood components occurs during chemi-mechanical pulping. All the existing chemi-mechanical processes have their advantages and disadvantages, and at the present time these processes can be classified into two main groups.

1. Processes where pulps are produced from logs
2. Processes where pulps are produced from chips

A discussion of some of the processes falling within these groups follows:

5. Chemigroundwood process

The chemigroundwood process is the main process in the first mentioned category of chemi-mechanical methods, but A. L. B. Semicell may also be considered as belonging to this group.

The chemigroundwood method, developed in the U. S. A., represents an interesting attempt to apply the conventional groundwood process to hardwoods; it includes mild chemical pretreatment of the wood in log form, followed by mechanical defibering in any conventional wood pulp grinder. The pulp is manufactured more succesfully from hardwoods than from softwoods, as coniferous woods do not respond as favourably to this type of chemical treatment.

The cooking liquor consists of a mixture of sodium-sulphite and sodium bicarbonate. The chemical consumption is about 10 - 12 per cent on the basis of o. d. wood. The chemically treated hardwoods are ground with 50 - 60 per cent of the power required for the manufacture of conventional groundwood pulp made from softwoods.

The main advantage of this process lies in the fact that hardwoods may be utilized for purposes which were earlier unpracticable; furthermore, the power consumption is less than for ordinary groundwood. Also, hardwoods are much denser than softwoods, and this allows of the production of approximately 25 per cent more pulp per unit volume of wood than can be obtained from softwoods such as spruce. Against these advantages, the chemical costs and the costs of building the digester house must be taken into consideration.

The pulp produced is much greater in strength than ordinary spruce groundwood pulp, and may be used as a part of the furnish for making newsprint. This pulp may also be bleached with peroxides or calciumhypochlorite.

6. Cold soda process

The cold soda process is the best known and the most widespread of all processes in the second group of chemi-mechanical pulping methods. However, this category also includes some processes used in making chemigroundwood pulp from chips with the same cooking chemicals as those used in the NSSC-process, for instance in the Stora Brite, Blandin and similar methods.

The cold-soda process (mainly employed in the USA) consist of two stages. First ~~of all~~ the chipped wood is treated with alkali without heat. The chips prepared in this way are defibrated in disc refiners. The chemical consumption, calculated on the basis of O. D. wood is 5 - 15 per cent.

The pulp produced is generally used as a part of the furnish for making newsprint; in addition, it has also been used for making food board and corrugated board. The pulp may be bleached with calcium hypochlorite, peroxide or hydrosulphite, and be converted into printing papers, mainly of the magazine-book type.

The main raw materials are northern hardwoods, but good results have also been obtained with semi-tropical hardwoods and eucalyptus. Agricultural residues and grasses may also be satisfactorily pulped by this process.

In 1961, about 50 per cent of all the mills in the world making cold soda pulp were located in the United States; but only a few mills in the world were making pulp by the other mechano chemical processes.

7. The groundwood process

The classical groundwood process was taken into use as early as in 1844, and its development since then has principally consisted of the building of larger and larger units. Nevertheless, within recent years, an attempt has been made in the United States to develop purely mechanical methods of defibration, generally based upon the use of disc refiners i. e. methods making groundwood pulp out of chips instead of the usual logs. Information contained in publications on the subject indicate that the problem has been already solved. It is thus to be expected that a new kind of technique will soon enter this field of pulp making.

The main advantage of the purely mechanical groundwood process is the almost quantitative yield obtained. The raw material generally consists of softwood, and particularly of spruce. The major part of the pulp produced in the world by this process is used in making newsprint. The pulp may be bleached by peroxides and hydrosulphites and converted into different kinds of printing paper. Groundwood pulp is also used for making different kinds of board.

8. Other processes

There follows below a brief discussion of the pulping methods principally used for making pulp out of agricultural residues and other one-year plants.

8(a). The monosulphite process

This process comprises cooking with a solution consisting of sodium sulphite with the addition of sodium carbonate or sodium hydroxide. Semichemical pulp may also be produced by this method. The method is especially applicable to straw and bagasse. The bleached pulp is suitable for the manufacture of writing and printing paper, and the semichemical pulp for making corrugating board. The chemical consumption is as follows neutral sulphite 36-37 kg/100 kg bleached air dry straw pulp, and 10-11 kg sodium hydroxide.

8(b). The soda-chlorine process

Two methods have been developed for making pulp from one-year plants by the aid of chlorine, i. e., the Vain and the Pomilio-Celdecor processes. The latter process is currently used on an industrial scale.

Pomilio-Celdecor is best known for the production of bleached straw and bagasse pulps; the process comprises four principal stages, viz. alkaline digestion, chlorination, extraction with alkali and hypochlorite bleaching. In the ideal soda-chlorine process, the consumption of caustic soda and chlorine are in the proportion obtainable by the electrolysis process of salt. It is important for this process that power is cheap. The method is most suitable for plant material of the non-woody type, and the principal raw materials are thus straw and bagasse.

Subsequent to the first stage, the pulp can be used for making yellow straw papers, straw board and corrugating board. The bleached pulp is very well adapted for different kinds of printing paper. In 1959, there were 28 plants in the world making pulp by this process. Apart from straw and bagasse, esparto is also pulped by the Pomilio-Celdecor process.

8(c). The cold alkaline method

Straw pulp made by a cold sodium hydroxide method is used for making pulp suitable for the production of greaseproof paper. By this method, straw is treated with sodium hydroxide in large chests for 15 days with no application of heat. However, this method is more or less a curiosity.

8(d). The mechano-chemical process

This process is carried out in a hydropulper with no pressure, but at a temperature of 98-99°C with sodium hydroxide or sodium hydroxide and sodium sulphide. The chemical consumption is 14-16 per cent on the basis of oven-dry bagasse. The process is also commonly used for making pulp out of bagasse.

The principal pulping processes used today on a commercial scale and their main characteristics have been briefly dealt with above. Apart from these processes, however, there are also methods which are generally speaking of academic interest alone. Of these, the following may be mentioned.

8(e). Nitric acid is used in France; it has recently also been used in Germany on a small scale, and has been put forward in the United States and Japan for the cooking of agricultural residues. Organic solvents such as alcohols, dioxane and glycols, have been suggested for the pulping of wood. Other agents which have been proposed for pulp-making from wood include chlorine, sodium hydrosulphite, sodium chlorite, klorohydrins and acetic acid. Hydrotropic pulping, using salts of xylenesulphonic, cymene sulphonic and benzoic acids, is one of the most recent methods proposed for the pulping of wood. The Kebra also deserves mention in this connection; it is an early pulping process utilizing sodium salts.

According to the World Review number of Pulp and Paper 1961, there are 55 nations producing pulp. The total production in 1960 of wood, straw, bagasse, esparto, bamboo and other pulps manufactured by these countries rose to 60, 019, 000 metric tons, amounting to a per capita production of pulp in the world of about 20. 5 kg per year in 1960. The paper consumption per head during the same year was 25. 0 kg. Of this world production of pulp 55 per cent is produced in the United States and Canada, 35 per cent in Europe, 7. 7 per cent in Asia, 1. 3 per cent in Latin America, 0. 8 per cent in Oceania, 0. 2 per cent in Africa. About 98 per cent of the pulp produced is made of wood, and the rest of agricultural residues and other one-year plants.

Conclusion

If a pulp mill has to be built, there are many circumstances which have to be considered, both economic and technical in nature.

Which is the pulp most desired in the particular area concerned? Are there sufficient indigenous raw materials suitable for this purpose? By which process may the desired pulp quality be produced from the raw material found in the area? Is this production economic in comparison with purchased pulp - paper? These are but a selection of the questions which demand an answer

When the location of the mill has to be decided upon, the transport costs for raw material vis-à-vis the transport costs for pulp have to be calculated. Furthermore, every pulp-producing mill must have adequate and substantial quantities of water which are sufficiently clean for the purpose. The demands imposed on the quality of the water are greater for bleached than for unbleached pulp production. This is a very important condition to bear in mind.

In the major pulp producing countries, the production units are very big, and within the units the changes brought about by technical development are slow. When new mills are planned, it is possible to apply to the project the most recent experience gained in the field. In the big pulp-producing units mentioned above, however, a long-term process of renewal is in progress.

But in the world today, there exists a large wood reserve still unexploited, particularly as regards pulp and paper making. I am thinking here of the great areas of tropical forest. Although these tropical stands make boast of a variety of trees, only a very few well known species have been utilized

mostly for mechanical wood processing. The species galore which surround these giants may be utilized for pulp and paper making. One difficulty which presents itself is the heterogeneity of these stands, a mixture of species varying in different districts. For this reason it may be a difficult matter to decide upon the most suitable pulping method for each case.

In some instances, the utilization of this raw material for pulp and papermaking may from a technical point of view be regarded as solved, but the economic problems involved will for some time to come preclude the use of this wood reserve to any major extent.

Annex I

Sulphite process
1)Ca(HSO3)2 + SO2
2) Mg(HSO3) + SO2
3) NaHSO3 + SO2
Bisulphite methods
1) Magnefite Mg(HSO3)2
2) Arbiso NaHSO3
Sulphate process NaOH + Na2S
Neutral Sulphite Semi-Chemical Process Na2SO + Na2CO3 NaHCO3 NaOH
Cold Soda method NaOH
Chemigroundwood method Na2SO3 + NaHCO3
Groundwood
Chemical treatment
Chemical + moderate mechanical treatment
Moderate chemical + mechanical treatment
Mild chemical + mechanical treatment
Mechanical treatment
Chemical pulp Yield 40-55 %
Chemical high yield pulps Yield 56-65 %
Semi-chemical pulps Yield 65-85 %
Chemi-mechanical pulps Yield 85-90 %
Mechanical pulps Yield 90-96 %

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ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.5.1.

Finland

THE PULPING PROCESSES OF TODAY AND THEIR MAIN CHARACTERISTICS

By Waldemar JENSEN, Professor,
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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

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The pulping processes of today and their main characteristics.

Waldemar Jensen, Professor, Doctor of Technology

Managing Director of the

Finnish Pulp and Paper Research Institute

Summary

The pulp industry of today is characterized by vigorous expansion, and alongside this rise in production far-reaching technical development is also in progress.

The principal raw materials for the production of pulp are softwoods and hardwoods, but in certain areas agricultural residues, grasses and reeds are also of importance.

Pulps may be classified according to the yield obtained; today it is possible to get any pulp yield desired between 35 and 100 per cent. A classification more correct from a theoretical standpoint might perhaps be made on the basis of the mechanical work needed to defibrate the wood which has to a major or minor extent been prepared by chemical treatment.

A brief description is provided of the main characteristics of the following processes and suitable utilization of the pulps produced:

The sulphite process, in its traditional form, continues to dominate the world production of sulphite pulp. The use of bases other than calcium, for example soluble bases, has recently shown a constant increase in some pulp producing countries. The most evident advantage of the sulphite pulping processes is that they give bright and easily bleached pulps, and these processes are extremely flexible as regards pulp quality. The major disadvantage of the conventional sulphite process is the difficulty experienced in pulping some common wood species. The main raw-materials are spruce and hardwoods. Annual plants are used in isolated cases only. Currently, this process is undergoing vigorous development. These improvements include: evaporation and combustion of the waste liquor, the use of soluble bases, multistage cooking, chemical recovery of soluble bases, and so on.

The Mg and Na bisulphite processes are very interesting and promising variants of the sulphite pulping process. In order to avoid attack on the fibres resulting from the acid nature of the conventional cooking liquor, these methods are based upon the same chemicals but with no excess of sulphur dioxide. They are particularly appropriate for hardwoods, but a wide variety of other wood species may be used. These methods are extremely flexible as regards pulp quality.

The sulphate process has always been marked by effective heat economy and

chemical recovery. Almost every kind of wood species may be utilized, and the process is also popular for straw, bagasse, bamboo and reeds. The paper obtained from this pulp is the highest in strength. The unbleached pulp is very dark, but can be bleached to a high degree of brightness and strength by means of chlorine dioxide. The method becomes more economic with increase in size of the units.

The semichemical process consists of a moderate chemical cook followed by mechanical fiberizing which completes the reduction of the chips to fibres. All the currently known chemical pulping processes may by adaptation enter the semichemical high yield range. The method most generally employed is the Neutral Sulphite Semi-Chemical process, known as the NSSC-method. Hardwoods are the main raw-materials, but straw and bagasse are also used. NSSC-pulps are easily hydrated, and are characterized by low opacity and great flexibility.

The chemigroundwood process constitutes an interesting attempt to apply the conentional groundwood process to hardwoods. A mild chemical treatment of the wood in log form precedes the mechanical defibration in any conventional wood pulp grinder.

The cold soda process is another chemi-mechanical pulping method which uses hardwood chips as raw-materials. Agricultural residues and grasses may also be pulped by this process. The chemically pretreated chips are defibrated in disc refiners.

The groundwood process generally makes use of softwoods, and particularly spruce, as raw-materials. The main advantage of the process is the almost quantitative yield obtained. A new method is being developed in which groundwood pulp is obtained from chips instead of logs.

Other processes, mainly used for the production of pulp from agricultural residues and other one-year plants, are mentioned and briefly discussed. These include the monosulphite process, the soda-chlorine process, the cold alkaline method and the mechano-chemical method.

Apart from these commercially employed processes, methods are mentioned which generally speaking are of academic interest alone, for instance the nitric acid method, although it is employed in a few cases, and methods using organic solvents. Hydrotropic pulping is one of the most recent methods mentioned.

Other agents proposed for the pulping of wood include chlorine, sodium hydrosulphite, sodium chlorite, chlorohydrins and acetic acid.

The circumstances which have to be considered if a pulp mill is to be built are mentioned, as well as the use of tropical woods for pulp and paper making.

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SUR L'APPLICATION DE LA SCIENCE ET DE LA TECHNIQUE
DANS L'INTÉRÊT DES RÉGIONS PEU DÉVELOPPÉES

Point de l'ordre du jour : D.5.1

Gabon

RECHERCHES SUR LA FABRICATION DE CELLULOSES AFRICAINES

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Les mémoires rédigés à l'intention de la Conférence des Nations Unies sur l'application de la science et de la technique dans l'intérêt des régions peu développées sont des documents de travail. Ils sont publiés tels qu'ils ont été présentés et les assertions et opinions qu'ils contiennent sont celles de leurs auteurs.

NOTES

1. Les mémoires choisis pour être présentés en séance générale pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

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REF. D.5.1. RECHERCHES DE LA FABRICATION DE CELLULOSES AFRICAINES

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1.- BESOINS MONDIAUX EN PATES A PAPIER

a) Les besoins en pâtes à papier ont considérablement augmenté au cours des dernières années. La production mondiale qui en 1936 était inférieure à 30 millions de tonnes est passée à 48 millions en 1953 puis à 62 millions en 1958. Le marché mondial de la pâte de bois s'élève maintenant à un niveau moyen de plus de 7 millions de tonnes contre 4 millions en 1948 et celui des papiers et cartons dépasse 10 millions contre 6 millions à la même époque. Pour toutes les nations on assiste à un accroissement constant de la consommation par habitant et cette tendance ne peut que s'accentuer au cours des prochaines années (Tableau 1).

b) Or les zones forestières du Nord, jusqu'à présent principales sources de cellulose, sont déjà largement exploitées et l'approvisionnement en bois et pâtes est devenu un problème important pour les pays pauvres en forêts de résineux. De grandes difficultés ont été rencontrées dans ce domaine au lendemain de la dernière guerre par de nombreuses nations importatrices. Une amélioration est intervenue au cours des dernières années d'une part en raison d'une intensification des productions nationales pour les pays importateurs, d'autre part en raison de possibilités d'exploitations forestières accrues pour les pays exportateurs. On ne peut donc parler actuellement de pénurie car l'offre est abondante sur le marché mondial, mais cette situation peut cependant évoluer rapidement au cours des prochaines années. En effet une récente réunion de la F.A.O. à Rome a mis en évidence que la consommation annuelle mondiale pourrait s'élèver à 80 millions de tonnes en 1965 et à 134 millions en 1975 ce qui répresente près de 300 millions de m3 de bois supplémentaire.

c) En 1959, Canada et Scandinavie réunis ont exporté 7 millions de tonnes de pâte environ, soit la presque totalité des exportations mondiales. Cette quantité, même doublée est donc loin de correspondre à la demande supplémentaire prévue pour 1975. On peut donc penser que vers cette époque, la demande en matières premières autres que les bois et les pâtes de résineux nordiques pour la fabrication de papiers sera beaucoup plus importante qu'elle ne l'est actuellement et les ressources en bois feuillus tempérés peut-être insuffisantes. Il serait alors normal d'envisager l'utilisation de la forêt tropicale dont la superficie est du même ordre de grandeur que celle des forêts de la zone Nord.

2.- ASPECT TECHNIQUE DE L'UTILISATION PAPETIERE DES FORETS AFRICAINES.-

a) Multiplicité de la matière première -

i) On sait que les bois résineux conviennent bien pour l'obtention de pâte à papier,

l'Epicéa et le Pin sylvestre représentant les deux types les plus appréciés. Ce sont les pays nordiques, riches en bois de qualité, qui sont les plus favorisés et il est normal que l'industrie papetière s'y soit particulièrement développée. Ces bois se distinguent en raison d'une certaine facilité de traitement par les procédés classiques : sulfate, bisulfite, mécanique, et en raison de l'excellente qualité des pâtes qui sont obtenues. Il faut également noter que l'importance des usines nordiques a permis la création de très nombreux laboratoires qui travaillent depuis des années sur une matière bien définie permettant ainsi d'obtenir un rendement maximum par des méthodes et du matériel bien adapté.

ii) On a cherché depuis le début du siècle à traiter par des méthodes similaires de nouvelles matières premières et on est ainsi parvenu à traiter d'autres variétés de résineux, et certains types de bois feuillus. On a également réussi à tirer parti de matières diverses : pailles, déchets industriels, bagasse etc... Initialement on a essayé de traiter ces matières avec les méthodes et le matériel déjà utilisés pour les résineux du Nord. Des difficultés se sont généralement présentées et il a été nécessaire d'adapter les méthodes et le matériel. Des modifications sont intervenues progressivement, accompagnées d'une amélioration des résultats. L'expérience a montré que des pâtes de qualités très différentes étaient obtenues selon les matières utilisées et ce n'est qu'après de nombreux essais que l'on est parvenu à mieux définir leurs possibilités d'emploi.

iii) Les premières recherches effectuées sur la matière première tropicale, et en particulier sur la matière première africaine, ont montré qu'elle était encore plus diversifiée. La plus grande partie de cette matière première est constituée de forêts comprenant dans quelques cas particuliers des bois résineux, mais dans la majorité des cas un très grand nombre de bois feuillus très différents les uns des autres. Quelques matières diverses comme les graminées peuvent également être utilisées bien que leur récolte en grande quantité pose des problèmes difficiles à résoudre. Une mention spéciale doit cependant être faite pour le bambou dont la sylviculture est connue.

iv) L'étude papetière de la matière première africaine est à peine commencée. L'étude de la forêt tropicale hétérogène nécessite en particulier l'inventaire et l'essai d'un nombre considérable d'essences. En réalité, le problème est très différent de celui qui se pose aux pays des zones tempérées. En effet, deux possibilités s'offrent au chercheur : soit tirer parti de la forêt hétérogène en utilisant n'importe quel mélange de bois, soit rechercher des essences de reboisement susceptibles de donner de bons résultats papetiers.

b) <u>Exploitation papetière des forêts hétérogènes de bois feuillus africains</u>.

1) L'utilisation d'essences tropicales en mélanges hétérogènes est nécessaire dans le cas des forêts africaines. On ne peut en effet utiliser séparément les nombreuses variétés de bois qui constituent la forêt car les qualités récoltées pour chacune d'entre elles seraient insuffisantes. Tout au plus pourrait-on penser à les grouper en lots de qualités voisines. Mais on s'est aperçu que le nombre de lots qui devraient être constitués était considérable.

ii) Pendant quelque temps on a pensé que ces difficultés s'opposeraient à toute réalisation industrielle car elles nécessitaient l'application d'un mode opératoire standard devant convenir à une matière essentiellement variable. Cependant à la suite de recherches effectuées au cours des dernières années, on a réussi à traiter par les procédés au sulfate ou soude-soufre des mélanges complexes de bois englobant des essences de nature très différentes. Des méthodes ont été prévues afin de limiter la variabilité de la qualité des pâtes obtenues car sur le plan commercial les usagers sont très exigeants en ce qui concerne la constance des qualités du produit fini.

iii) Les perspectives d'utilisation des mélanges hétérogènes de bois feuillus africains semblent moins favorables en ce qui concerne d'autres procédés de fabrications classiques comme les procédés mécaniques, monosulfitiques, ou bisulfitiques et les résultats obtenus sont encore insuffisants pour que l'on envisage actuellement de les transposer à l'échelle industrielle.

iv) Les possibilités d'utilisation de mélanges hétérogènes de bois correspondant au "tout venant" d'une forêt africaine sont donc provisoirement limités. Seule la fabrication de pâte kraft peut être envisagée avec un minimum de risques.

c) Exploitation papetière des essences tropicales de reboisement -

i) On pourrait conclure des observations précédentes qu'il est préférable d'utiliser des essences sélectionnées de reboisement. Mais l'utilisation de bois de plantations artificielles peut soulever également certaines difficultés.

ii) Il faut d'abord sélectionner les essences les plus intéressantes pour l'industrie papetière. En principe, des variétés de résineux seraient souhaitables. On connaît quelques variétés de pins qui peuvent s'adapter aux régions subtropicales africaines, mais il ne semble pas que l'implantation de résineux en zone tropicale soit facile et les forestiers préfèrent envisager dans bien des cas des peuplements de bois feuillus. Quelle que soit l'essence retenue, une période expérimentale plus ou moins longue est nécessaire avant d'entreprendre des plantations à grande échelle. Une certaine prudence est de rigueur au cours de ces recherches car des erreurs peuvent être commises; il faut prendre soin d'étudier de nombreux échantillons ayant poussé sur place, même si des informations favorables ont été obtenues par ailleurs.

iii) Enfin, l'utilisation exclusive d'essence de reboisement ne supprime pas pour autant toutes les difficultés techniques et il est rare de rencontrer des échantillons répondant favorablement à n'importe quel procédé de fabrication.

iv) Les recherches entreprises permettent d'espérer dans un proche avenir la sélection de nouvelles essences. Mais un effort soutenu de la part des sylviculteurs et des techniciens sera encore nécessaire avant qu'il ne soit possible d'exploiter industriellement les bois qui auront été retenus.

d) Utilisation locale des pâtes tropicales pour la fabrication de papier.

i) L'utilisation sur place des pâtes tropicales pose des problèmes différents selon la qualité des papiers que l'on cherche à obtenir.

ii) La fabrication de papier d'emballage à partir de pâtes alcalines est possible mais on demande généralement à ce type de papier des caractéristiques mécaniques très élevées. Il n'y a pas de difficulté si on dispose de résineux ou de bambous, mais il n'en est pas de même dans le cas des bois feuillus. Les pâtes de mélanges hétérogènes de bois feuillus africains peuvent convenir si l'on ne se montre pas trop exigeant en ce qui concerne les caractéristiques mécaniques des papiers; ces pâtes contiennent en effet des fibres très diversifiées dont certaines assez longues confèrent un minimum de résistance. Mais l'utilisation des essences feuillues de reboisement à croissance rapide est plus difficile car les pâtes sont alors composées de fibres courtes et les papiers qui sont obtenus résistent mal à la déchirure. Les essences feuillues à fibres longues qui nous sont actuellement connues correspondent à des essences à croissance lente dont la plantation offrirait moins d'intérêt même si les problèmes sylvicoles étaient résolus. Pour des papiers d'emballage de bonne qualité, il faut donc prévoir dans de nombreux cas l'incorporation de pâtes à haute tenacité qui doivent être importées.

iii) La fabrication d'autres papiers, en particulier les papiers de presse, d'impression, d'écriture est encore plus difficile. Ces papiers sont composés en effet d'un mélange de pâtes de nature très différente: pâtes chimiques alcalines ou au bisulfite, pâtes mi-chimiques, pâtes mécaniques, ces deux dernières catégories entrant en proportions élevées dans les compositions. On a signalé les difficultés rencontrées pour la fabrication de ces deux types de pâte dans le cas de très nombreuses essences africaines pour lesquelles il est plus facile d'appliquer un traitement chimique alcalin. La fabrication de papier de presse, d'impression ou d'écriture sera donc beaucoup plus délicate si on veut éviter l'importation de pâtes. On peut également penser que la fabrication de certains cartons soulèvera des difficultés semblables.

iv) Pour ces diverses raisons, on peut admettre que les premières usines africaines situées en zone tropicale seront de préférence orientées vers la production de pâtes chimiques, plus facile à obtenir sur le plan technique. La production de papier sera au contraire limitée. Les pâtes chimiques de résineux sont commercialisables. Les pâtes blanchies de feuillus également. On ne peut prévoir exactement l'accueil qui serait réservé par les papetiers à des pâtes tropicales dont ils n'auraient aucune expérience, On peut cependant espérer d'après les premiers travaux effectués que ces pâtes trouveraient des débouchés normaux auprès des utilisateurs.

3.- PROBLEMES LIES A L'IMPLANTATION D'UNE INDUSTRIE PAPETIERE EN AFRIQUE TROPICALE.-

a) Capacité des usines -

i) L'industrie papetière, autrefois artisanale, est devenue une industrie lourde qui tend à se moderniser en réalisant d'importants investissements, ce qui se traduit par l'apparition d'un matériel amélioré et par un accroissement de la productivité de chaque entreprise.

ii) Sur le plan international, on observe de nombreuses unités produisant plus de 100.000 tonnes de pâte par an et parfois plus de 200.000 tonnes. On envisage la création d'unités plus importantes encore. Les petites entreprises dont les installations sont amorties depuis de nombreuses années ne survivent généralement qu'en se spécialisant dans les fabrications particulières pour lesquelles l'expérience des techniciens et la qualité des produits fabriqués joue un rôle important. Cette course à la productivité ne peut manquer d'avoir une incidence sur les prochaines réalisations africaines. Le seuil de rentabilité d'une entreprise est variable et dépend de nombreux facteurs. Il n'est pas possible de le déterminer sans une étude détaillée de chaque cas particulier. Si l'on se rapporte aux plus récentes réalisations signalées en zone tropicale, il ne faut pas envisager la construction d'usines d'un tonnage inférieur à 30.000 tonnes par an. Dans bien des cas le seuil de rentabilité pourrait même se situer au-dessus de 50.000 tonnes.

b) Difficultés économiques -

i) Les investissements nécessaires à l'implantation d'une unité papetière sont donc considérables en raison même de l'importance des usines; mais ces investissements sont également plus élevés en zone tropicale car de nombreux facteurs contribuent à élever le coût des installations. Le transport de machines sur de longues distances, l'installation de nombreux ateliers de réparation, la nécessité de stocker un important matériel de rechange, un coût plus élevé de la construction contribuent à augmenter les frais d'implantation. Pour certains pays africains, il faut également tenir compte d'autres facteurs : frais d'équipement et d'entretien forestiers élevés, nécessité de prévoir des services sociaux et communautaires, des logements pour les cadres et le personnel autochtone, la construction de routes, etc... L'incidence sur le prix de revient des produits fabriqués est donc particulièrement sensible, même si les gouvernants locaux apportent une contribution en ce qui concerne certains frais communautaires.

ii) On pourrait supposer que l'échelle des salaires qui a cours dans les pays africains compense en partie ces inconvenients. Mais dans bien des cas, une productivité limitée de la main-d'oeuvre autochtone qui manque de formation et la nécessité de faire appel à des cadres étrangers ne permet pas d'envisager un abaissement sensible de la somme des salaires.

iii) Il faut également envisager, dans le cas d'une unité fricaine, une plus longue période de mise en route, ceci pour des raisons évidentes relatives aux difficultés techniques et à la nécessité d'adapter le personnel local.

iv) Il résulte de ces différentes remarques que le prix de revient des bois tropicaux rendus usine a une importance primordiale puisque dans de très nombreux cas, c'est le seul élément qui permette de compenser des frais particulièrement élevés par ailleurs.

c) Débouchés commerciaux -

i) Si quelques nations africaines ont une consommation locale relativement plus élevée nombreuses sont encore celles qui ne pourraient actuellement absorber la production d'une usine moderne (Tableau 2). Il faut dans ce cas envisager l'exportation d'une grande partie des produits fabriqués. Le transport des pâtes et papiers sur de longues distances en augmente le prix de revient et rend leur vente plus difficile sur un marché concurrentiel.

ii) Les difficultés occasionnées par l'approvisionnement mondial en pâtes à papier et papiers après la dernière guerre ont été la cause de nombreux investissements, et, bien que la consommation mondiale ait augmenté, le cours actuel des pâtes est assez bas.

iii) Il est difficile de prévoir quelle sera l'évolution du marché des pâtes au cours des prochaines années. La dernière réunion de la F.A.O. laisse prévoir que la demande mondiale en pâte à papier doublera en 1975. Mais les experts consultés ont fait remarquer que de nombreux pays prévoyaient la construction de nouvelles usines. Aussi, bien qu'il soit possible que la position des pays africains puisse s'améliorer en raison d'une production nordique relativement moins importante par rapport à la production mondiale, les risques de concurrence ne doivent pas être écartés.

4.- PERSPECTIVES D'AVENIR -

a) On conçoit qu'en raison des difficultés techniques et économiques dont il vient d'être question, l'évolution et l'industrie papetière dans les pays tropicaux ait suivi un cours différent selon la situation géographique, les ressources forestières et le degré de développement industriel.

b) Jusqu'à présent, seuls les pays bénéficiant d'une consommation locale suffisante avaient pu s'équiper en matériel de papeterie. C'est pourquoi à l'exclusion des zones Nord et Sud de l'Afrique, ce continent ne possède pas encore d'industrie papetière. Cette condition particulière du continent africain semble cependant devoir prendre fin car un certain nombre de projets sont depuis quelques années en cours d'étude ou de réalisation : achèvement d'une fabrique de pâte à papier en Angola, reconversion et extension d'une première usine expérimentale en Côte d'Ivoire, étude d'une fabrique de pâte au Gabon, etc... L'industrie papetière qui après l'ère du chiffon s'était déplacée vers le Nord tend maintenant à se rapprocher de l'équateur et on peut prévoir que les recherches qui se poursuivent actuellement pour l'utilisation des ressources africaines contribueront amplement et accélérer ce mouvement.

Tableau I : Statistique des consommations de papiers et cartons par habitant et par an (Kilos) :

Nations	1937	1955	1959
U.S.A.	140	170	200
Suède	56	72	110
France	30	42	52
Chine	0.5	1	2
Madagascar	-	0.6	1
Afrique Occidentale	-	-	0.7

Tableau 2 : Statistique des consommations de papiers et cartons par nation et par an : (Tonnes)

Nations	Consommation annuelle (1)	Nombre de papeteries	Nombre de fabriques de pâtes
U.S.A.	34.000.000	816	365
France	2.500.000	284	54
Brésil	650.000	73	18
Inde	400.000	(- - 27 - -)	
Union Sud Africaine	350.000	9	4
Chili	80.000	5	0
Ceylan	20.000	1	1
Congo ex Belge	20.000	0	0
Costa Rica	7.000	0	0
Madagascar	moins de 5.000	0	0
Libéria	"	0	0
Gabon	"	0	0

(1) : Tonnage approximatif en 1959

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SUMMARY

Agenda Item: D.5.1

Gabon

RESEARCH INTO CELLULOSE PRODUCTION IN AFRICA

By G. PETROFF,
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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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RESEARCH INTO CELLULOSE PRODUCTION IN AFRICA

By

G. PETROFF, E.F.P. ENGINEER, HEAD OF THE CELLULOSE DIVISION, TROPICAL FORESTRY CENTRE, NOGENT-SUR-MARNE, FRANCE, and LIBREVILLE, GABON.

D.5.1.

SUMMARY

1. World demand for pulp

In recent years there has been a considerable rise in world consumption of pulp, and demand is expected to double by 1975. By then, the demand for raw materials other than northern softwoods and pulps will be far greater than at present. Consequently, it is to be expected that tropical timber will be used for making cellulose.

2. Technical aspects of the question

(a) Variety of raw materials.

Earlier research revealed the wide variety of Africa's forest resources which include a very large number of hardwoods, falling broadly into two classes: heterogeneous mixtures of timbers of variable and ill-defined quality, and planting species of better-known quality.

(b) Use of heterogeneous African hardwoods for papermaking.

Heterogeneous mixtures of African hardwoods can be used to produce unbleached and bleached alkaline pulps, but the production of other types of pulp from this source is much more difficult.

(c) Use of tropical planting species for papermaking.

Species are being selected for planting but the most suitable varieties for papermaking are often difficult to acclimatise. It will be many years before these plantations can be exploited industrially.

(d) Local use of tropical pulps for papermaking

The range of papers that can be manufactured locally from tropical African raw materials is often limited, and in such cases additional supplies of pulp have to be imported.

3. Problems of establishing a paper pulp industry in tropical Africa

(a) Problem of capacity: Mills must not be too small, as they would probably be uneconomic.

(b) The economic problem: Installation costs are always heavy and even higher in the tropics. The price of tropical pulpwood delivered to the mill is of primary importance, as the only element offsetting other charges, which are very high.

(c) Problem of markets: At present few African countries could absorb the entire output of a modern mill. A large part of output would have to be exported to highly competitive markets.

4. Future prospects

Despite these difficulties, plans are being made or actually taking shape in several African republics. Further research will accelerate these developments.

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UNITED NATIONS CONFERENCE
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Agenda Item: D.4.2

United Kingdom

PRESENT AND FUTURE TRENDS IN THE USE OF PLASTICS, PAPER AND BOARD FOR PACKAGING AND DISTRIBUTION

By David J. LISTON, M.B.E.

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Agenda Item D.4.2.

PRESENT AND FUTURE TRENDS IN THE USE OF PLASTICS, PAPER AND BOARD FOR PACKAGING AND DISTRIBUTION

David J. Liston, M.B.E.

1. (a) Packaging is one of the great growth industries of modern times. The industry itself is, however, quite old and there are packaging companies in England and elsewhere with a record of continuous activity for nearly two hundred years. These companies are mostly converters of paper and paper products; for paper, in addition to being one of the most widely used of packaging materials, is also one of the oldest.

Plastics, by way of contrast, are very new in the packaging field. Plastic bottle closures made of thermosetting materials have been with us for many years. But the thermoplastic materials are very new, most of them having been developed within the last thirty years. It is this group of materials with which this paper is most concerned; for either by themselves or in conjunction with paper and other materials, they possess individual properties of the greatest possible value in the packaging field.

(b) These materials have appeared at a time of almost continuous growth and expansion in the packaging industries of the world. For packaging is an intermediate service industry, providing the agricultural and manufacturing industries of a country with the means to distribute their products. The consumption of packaging materials tends therefore to be a barometer of economic progress, and to grow in volume and sophistication with the social and economic development of individual countries. It follows therefore that a country's packaging industry is more than usually sensitive to the major factors affecting the national economy. Its growth follows very closely the pattern of the growth of the national income as a whole. It reflects changing patterns in consumer expenditure. It must repond to changing technologies in production not only of food but of many other manufactured goods. Finally it is affected by changing fashions in

marketing, advertising and distribution - all of which again are seeking continuously to adjust themselves to the tastes and fashions of the consuming public.

2.(a) On the whole the packaging industries of the world have met this challenge with outstanding success. The tinplate can and the glass bottle in particular have sustained a remarkable rate of growth both in England (see Table 1. in Annex) and in many other countries of the world.

(b) Progress has, however, been most spectacular amongst the "soft" packaging materials - plastics, paper and board. For these materials are particularly well placed to exploit modern trends, both in manufacture and distribution. They are well suited to the packaging of frozen and dehydrated foods which represent the major recent advance in food technology. Their low cost and light weight make them attractive for the packaging of small or individual units, particularly in the field of pharmaceuticals. Finally, the rapid growth of branding and of self service distribution has created a demand for attractive, printed bags and wrappers for a range of goods which were previously either packaged in the simplest possible form, or distributed in bulk with little or no attempt to package in individual retail units.

(c) Table 2. showing the growth in consumption of Polyolefin (plastic) films in various countries, reflects this dynamic progress. It will be seen that in the U.S.A. and France consumption has more than doubled in the past five years, while in Germany there has been a four-fold increase. Some 80% of this film is used for packaging. The United Kingdom figures show similar trends and consumption of plastic film for packaging in 1962 was in the region of 25,000 tons - a figure more than twice as high as that of five years ago. Statistics for other countries of the world are not easily available, but there is little doubt that parallel or even greater advances have been made elsewhere - in India, South Africa, Australia, Latin America and Japan.

(d) Paper packaging has had many years in which to consolidate its growth. But for all that its rate of expansion continues to be very remarkable indeed. Sales of cartons, cardboard boxes and fibreboard cases in the United Kingdom rose from under £100,000,000 in 1954 to over £140,000,000[1] in 1960 - years when the price of paper and board was in decline. Paper consumption in Western Germany has increased in recent years by some 10% per annum; in U.S.S.R. by 11% and in Japan 15%.[2] There is every reason to believe that the increase in packaging papers and boards in these countries was at least equal to the average increase over the paper industry as a whole.

3.(a) Many of the factors which led to this expansion still persist both for paper packaging and for plastics. Firstly there have been huge developments in packing machinery to overcome handling difficulties with some of the newer materials. Manufacturers have been particularly active in Scandinavia, Holland, Western Germany and Japan as well as in England and America. High speed systems have been developed for

forming and filling cartons. These cartons can have a heat seal coating which seals merely with heat and pressure. New machines have speeded up printing and bag making for paper, film and laminates as well as for closing and sealing this wide and complex range of materials. These developments, which have led to cheaper packaging operations and higher efficiences on the production and filling lines, have been matched by the falling price of packaging materials, which themselves have been subject to continual development.

(b) There have been many refinements, for instance, both in the techniques of paper and board manufacture, and most particularly in the techniques of coating and laminating. A number of these developments incorporate other materials, notably plastic films and coatings, and aluminium foils. As a result the paper and board converters have developed a spectacular range of new products - fibreboard outer containers, multi-wall paper sacks, liquid-tight cartons and coated wrappers and cartons for frozen foods and other perishable products.

(c) (i) Developments in plastics have been even more rapid and far reaching. Polythene was one of the earliest thermoplastic materials to be used extensively for packaging - first as a transparent film, and subsequently as moulded packages and components, particularly "squeeze" bottles. Polythene is also extensively used as a heat-seal coating for both paper and aluminium foil; whilst it is also in growing demand as a moisture proof and protective lining for both multi-wall paper sacks and metal drums. More recently polythene is being vacuum formed to produce a hermetically-sealed container for frozen foodstuffs. Nearly 50% of all the polythene consumed in the United Kingdom is now used for packaging. This rapid growth has been stimulated both in England and elsewhere by a continuous decline in polythene price and also by technical developments both in the polymers and in processing techniques. As a result, polythene today is not only one of the most widely used packaging materials but also one of the cheapest.

(ii) Polystyrene is another of the "older" plastic materials to benefit both from a continuous fall in price and from successful technological progress. It has flow characteristics which make it particularly suitable for injection moulding and it is therefore widely used for can and bottle components as well as for injection moulding containers. More recently it has been used for vacuum forming - a process particularly popular for drinking cups, tubs and for the packaging of fruit juices and other liquid products. Finally it has been discovered that extruded polystyrene acquires most valuable properties by stretching in both directions, known as bi-axial orientation. A film of this material, brilliantly clear and most attractive in appearance, is now being produced both in America and Europe.

(iii) The latest arrival on the scene is Polypropylene, a material of most exciting properties with a wide range of uses in the packaging field. Once more it seems probable that its biggest use will be as bi-axially oriented film. This film is already being produced in America and

production is expected in the near future in England, Belgium and Japan. The film is very clear; it has useful protective qualities and because it can be produced in very thin gauges it will compete in price not only with cellulose film with which it is already competitive, but eventually with polythene and the cheaper plastic materials.

(iv) It is not possible in this paper to describe all the recent developments in plastic materials. Both Polyvinyl Chloride (P.V.C.) and Polyvinylidene Chloride are materials which have been extensively used for some years but which continue to find new applications in the packaging field. There are new groups of materials also - such as the polycarbonates which are only just appearing on the packaging scene. And others, such as Polyester films where full exploitation has so far been limited by the cost of the material. These, and many others, will undoubtedly help to sustain the lively and competitive atmosphere which is the main feature of the industry today and which has done more than anything else to sustain its rate of growth and expansion in so many different countries of the world.

4.(a) There seems little doubt, therefore, that both in paper and plastics the packaging industries of the world are set for an expansion in the future, at least as great as they have enjoyed in the past. It remains, therefore, to consider whether the trends amongst the package consuming industries are following a similar course, in particular whether they are likely to create a demand for packages on a scale which will justify all the development effort of the packaging industries and fill the productive capacity which these industries have already created or plan to create in the future.

Here it is important to bear in mind once again the major features which have supported the growth in packaging in recent years:

a) Rapid advances in the technology of the package consuming industries, particularly in manufactured foodstuffs.
b) Changes in marketing and distribution.
c) Changes in social tastes and consumer habits.
d) Increasing expenditure on packaging with the growth of national incomes.

An examination of these factors will show that while the rate of advance in certain countries of the world may be less rapid than in the past, there are many countries in the world where packaging consumption is still very low and where there is every hope that the rate of growth will be very rapid indeed. And for many reasons, both technical and commercial, it is the paper and plastic industries which are likely to benefit most from increased package consumption amongst the less developed nations of the world.

(b) (i) The trends in marketing and distribution are in favour of the "soft" packaging materials - particularly transparent plastic films. Modern marketing involves the branding of the product and a high level of presentation and display. The product has often to sell

itself, backed only by mass advertising and promotion aids. The self service store is the ultimate in this form of distribution, and despite the rapid increase in self service distribution, there is every reason to expect an even faster expansion in the future. In America nearly 60%[3] of grocery outlets are now self service, and it is estimated that some 90%[4] of all food sales in that country are made in this way. Table 3 in the Annex shows the comparative development in various European countries.

(ii) Current progress appears to be fastest in Germany, where there are said to be 30,000 self service stores, accounting for 35 - 40% of all retail food sales.[5] In Britain, progress[6] whilst slower, has also been very great and there are now 8,800[6] self service stores in the country. In all countries, self service distribution has extended far beyond foodstuffs, and the modern supermarket sells the widest range of goods from textiles to refrigerators. Nor is this development confined to Europe. There are supermarkets in Kenya, Singapore, Indonesia, Iran and many other countries of the world.

(iii) Self service demands that every article sold should be individually packaged and clearly marked with price and contents. As a result, packaging has extended far beyond the range of manufactured goods. In particular, pre-packaged fresh produce accounts for a vast tonnage of plastic film, wrappers and cartons. Basic commodities such as potatoes, fruit, meat, butter, cheese and eggs all now fall within the scope of the packaging industry. They all present difficult technical problems to the package manufacturer, and most of them offer unlimited opportunities for expansion in the future.

(c) We have already referred to recent advances in food technology - particularly quick-freezing and dehydration. The technique of both freezing and drying continues to advance and there is a steady improvement in the quality, range and presentation of the products. Quick frozen foods are successfully packed in cartons, plastics or films. Plastic coated board is increasingly used for the carton; in this way it has been possible to design high-speed filling and sealing lines and at the same time provide a greater degree of protection for the product. Many dehydrated products - such as soup and "instant" potato - are packed in laminated pouches made of paper, film and in some instances, metal foil. Accelerated freeze-drying, however, produces a most brittle and friable product and its successful packaging calls for considerable ingenuity. A number of experimental packs have been developed, incorporating paper, board and the newer plastic films. Whatever the ultimate form of packaging there is no doubt that the process offers exciting possibilities for the distribution of perishable goods. Powdered milk is another product to turn to a combination of paper and plastics for its newer forms of packaging, whilst vacuum packaging of bacon makes use of a coating of polythene on to a cellulose film - a film which in turn has often itself been previously coated with Polyvinylidene Chloride, and the print is sandwiched hygienically between the two films.

(d) There are numerous other developments which promise equally great opportunities for both paper and plastic packaging. Many products, particularly food and pharmaceutical, are now offered in small individual units. Flexible packages of paper, film or laminates reduce the packaging cost to a minimum. They give adequate protection to the product and provide a simple method of sealing and dispensing. Many products which were previously sold as powders or pastes now are offered in liquid form for convenience of dispensing and application. Detergents, bleaches and household polishes are outstanding examples; they account for a very substantial proportion of the world demand for polythene bottles.

Motor oil is already appearing in its first plastic packs. A start has also been made with soft drinks, liquid milk and even wine. Indeed the variety of products is endless and between them they should ensure a continuing and growing demand for both paper and plastic packaging.

5.(a) These trends and developments, many of which started in America, are already spreading throughout the world. Moreover there are a number of applications which are either being pioneered in the less developed countries or which are already being extensively exploited there because of some particular local circumstances. So far as agricultural products are concerned packaging is already well developed in many countries, much of it carried out in co-operative pack houses. In this way the products of both tropical and temperate climates are prepared not only for domestic consumption but also for the requirements of the export markets.

(b) There are also other more specialized packaging developments in many countries. Plastic films are being widely used as a container for saplings and seedlings in a number of countries in Africa and Asia. Cocoa plants are being wrapped in Ghana, tobacco plants in Rhodesia, coffee plants in Kenya. In Malaya trials are being carried out on a system of planting rubber saplings at certain stages in a black polythene bag. It is hoped that this system will permit tapping to start after five years instead of the usual seven. Polythene shrouds are being widely used for wrapping bananas in Jamaica, in the Windward Islands, in Central America and in West Africa. Both plastics and paper are being used in East Africa for the packaging of liquid milk. Nigeria is packing large quantities of sweets in plastic bags, and Gari, a food made from the roots of a shrub which is widely consumed in West Africa, may in the near future be pre-packed in a plastic bag.

(c) Heavy duty polythene sacks are being extensively developed for the packing of fertilizer, chemicals and animal foodstuffs. In India there is a large usage of polythene as a lining material for either paper or jute sacks. Other products which are currently being packed in polythene are wax in Borneo and wet fish, which has been transported by air in bags from Iceland.

(d) India has made progress in single-unit pilfer-proof packs. Indeed a pavilion at the India Industries Fair in 1961 focused attention on the success of pilfer proof packaging in combating the adulteration of foodstuffs and trafficking in spurious drugs. There are various products packed in laminations. These include dried fruit in South Africa, medicine tablets in strip packs in Pakistan and other countries, and nuts and dried peas. Rice, sugar and salt are all commodities suitable for packaging in paper or plastics. Others, particularly perhaps ghee and fatty products, still present a technological problem for the future.

6.(a) In this paper I have described new trends in manufacture and distribution which quite clearly reflect a major revolution in the tastes and preferences of the consuming public. There is a continuing emphasis on "convenience foods" and on the familiarity and security of brand names associated with uniform standards of quality, safety and hygiene. Moreover, there is the complexity of individual requirements which arise from higher standards of living and from personal budgets, which reach beyond the basic necessities of day to day existence.

(b) Many of the trends, of course, have already been fully exploited in a number of countries of the world. In the U.S.A. in particular it would be unwise to expect a rate of progress in future equal to that of the last ten years. In Western Europe many of the trends have still to develop real momentum; in a number of countries they have scarcely started. Table 4 in the Annex shows the per capita consumption of paper and board (other than building board) in the year 1958. The figures are similar for other packaging materials.

(c) I have also described the increasing uses of packaging in developing countries and the challenges they present. There is no doubt that this challenge will be met. For the manufacture of paper and plastic packaging can commence with a relatively low capital outlay. Technological help is available from the material manufacturers, from the makers of packaging machinery and from the major package manufacturing countries. The materials and processes are well suited to making small packages, a factor of great importance in countries where the purchasing power is low. The packages themselves are light in weight thus reducing costs of transportation and storage. Finally the range of protective qualities is great enough to stand up to most of the extremes of climate and temperature. There can be no doubt that packaging will expand in the less developed countries in view of the variety and significance of their new packaging developments. Between them they must surely ensure for many years ahead a steady rate of growth in the paper and plastic industries of many different countries of the world.

"Table 1" GROWTH OF OLDER PACKAGING MATERIALS IN ENGLAND

Year	Tinplate Consumption used for Containers Thousand Tons	Glass Container Sales - Millions
1948		2,815
1950	380 (estimate)	-
1954		3,530
1958	536	4,050
1961	611	4,545

Sources: Glass Manufacturers Federation. Iron and Steel Board. Although no published figures, estimated that consumption of tinplate food containers has more than doubled in the last five years.

"Table 2" POLYOLEFIN FILM CONSUMPTION (Thousand Tons)

Year	U.K.	U.S.A.	Western Germany	France
1957	8	70	7	5
1959	13.5	104	16	7
1961	23	150	28	13

All figures are estimates based on Polyolefin Consumption figures in British Plastics and Modern Plastics.

"Table 3" GROWTH OF SELF SERVICE STORES

	Number of Self Service Stores		Number of people per Self Service Store (In thousands)		Self Service as a % of Grocery Outlets (Estimated)
	1957	1960	1957	1960	1960
U.K.	3900	8150	12.8	6.4	4.7
Sweden	3515	5451	2.1	1.4	29.0
Germany	3183	22612	17.0	2.2	13.8
Italy	33	400	1507.0	123.0	0.1

Source: O.E.E.C. Report on Self Service Stores in Europe.

"Table 4" PER CAPITA CONSUMPTION OF PAPER AND BOARD IN 1958

	Population (Millions)	lbs. per Head
U.S.A.	174	400
Sweden	7.4	222
U.K.	52	198
Germany	53	145
Italy	49	51
Mexico	32	29
Pakistan	84	2

Source: Pulp and Paper International World Review, 1959.

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SUMMARY

Agenda Item: D.4.2

United Kingdom

PRESENT AND FUTURE TRENDS IN THE USE OF PLASTICS, PAPER AND BOARD FOR PACKAGING AND DISTRIBUTION

By David J. LISTON, M.B.E.

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SUMMARY

PRESENT AND FUTURE TRENDS IN THE USE OF PLASTICS, PAPER AND BOARD FOR PACKAGING AND DISTRIBUTION

David J. Liston, M.B.E.

1. Packaging is one of the great growth industries of modern times. In this paper we are concerned mainly with paper and plastic packaging, especially thermo plastics as they possess properties of the greatest value in the packaging field. Packaging is an intermediate service providing industry with the means of distributing their products. It is sensitive to changes in the national economy and therefore tends to be a barometer of economic progress.

2. Although the tinplate can and glass container have maintained a remarkable growth in the last decade, progress has been most spectacular among the "soft" packaging materials - plastics, paper and board. They are well suited to modern needs as they are attractive, light in weight and cheap. Moreover the growth of branding and of self service has created a demand for a wider range of attractively wrapped goods.

Consumption of Polyolefin (plastic) film in the U.S.A. has more than doubled in the last five years, and some 80% is used for packaging. Paper packaging has also increased very fast and paper consumed has risen in many countries especially Germany and Japan.

3. Many factors which led to this expansion still persist. There have been many innovations in packaging machinery and many refinements in the techniques of paper and board manufacture; particularly in laminations and coatings incorporating other materials notably plastic films and aluminium foils. As a result paper and board converters are able to offer a spectacular range of new products.

Developments in plastics have been even more far reaching. Polythene is used as a transparent film and for moulded articles, particularly squeeze bottles. Recently it has been used as a heat seal coating for other materials. Nearly 50% of polythene today is used for packaging.

Like polythene, polystyrene has benefited from falling prices. It is widely used for injection moulded articles. It has also been discovered that when stretched (bi-axially oriented) a brilliantly clear and attractive film is produced. The latest arrival, Polypropylene,

is also likely to be used as a bi-axially oriented film. As it may be produced in very thin gauges, it will compete with cellophane film and may soon challenge cheaper materials.

4. There seems little doubt that there will be future expansion in packaging, and it remains to consider trends in package consuming countries. The major features supporting the growth of packaging have been: Advances in technology: changes in marketing and distribution as well as social tastes and habits and increasing expenditure on packaging with the growth of national income.

There have been great advances in self service, especially in America but also in Europe. In Germany there are now 30,000 self service stores accounting for 35/40% of retail food sales. There are indeed supermarkets all over the world. Self service demands pre-packing of every article and presents unlimited opportunities for expansion.

The recent advances in food technology, such as quick freezing and dehydration make new demands on packaging. Many foods are packed in cartons with a plastic coating or in laminated pouches. Bacon is vacuum packed in a cellophane/polythene pouch. There are numerous other developments; detergents, bleaches, polishes and motor oil are all now offered in plastic bottles. A start has been made in soft drinks, milk and even wine.

5. These trends and developments are spreading throughout the world in the less developed countries. Many operations are carried out through co-operative pack houses. In this way both tropical and temperate products are prepared for domestic and export markets.

There are other more specialized applications in various countries. Plastic films are used as containers for seedlings and as shrouds for bananas. Milk in East Africa and sweets in Nigeria are packed in polythene bags. Polythene sacks are used for packing fertilizers and animal foodstuffs. India has made progress in pilfer-proof packs. Various products, such as dried fruit, nuts, dried peas and tablets are packed in laminations.

6. This paper describes new trends which clearly reflect a revolution in tastes and preferences of the public. Many trends have been already fully exploited. In the U.S.A. in particular it would be unwise to expect such fast growth as in the last 10 years; but in Western Europe many trends have still to develop full momentum. Per Capita consumption of paper shows European Countries to have a substantially smaller consumption than the U.S.A.

In some countries these trends are just beginning and for many reasons paper and plastics offer attractive possibilities. Paper and plastics can commence with a relatively low capital outlay and are well suited to making small packages, a factor of great importance in countries where purchasing power is low. Their light weight facilitates transportation and their properties are comprehensive enough to stand up to the extremes of climate. There is little doubt that developments in the emerging countries will ensure a steady rate of growth of packaging for many years.

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